INSTRUCTION MANUAL

MODEL ~~PM3-11A-1~~

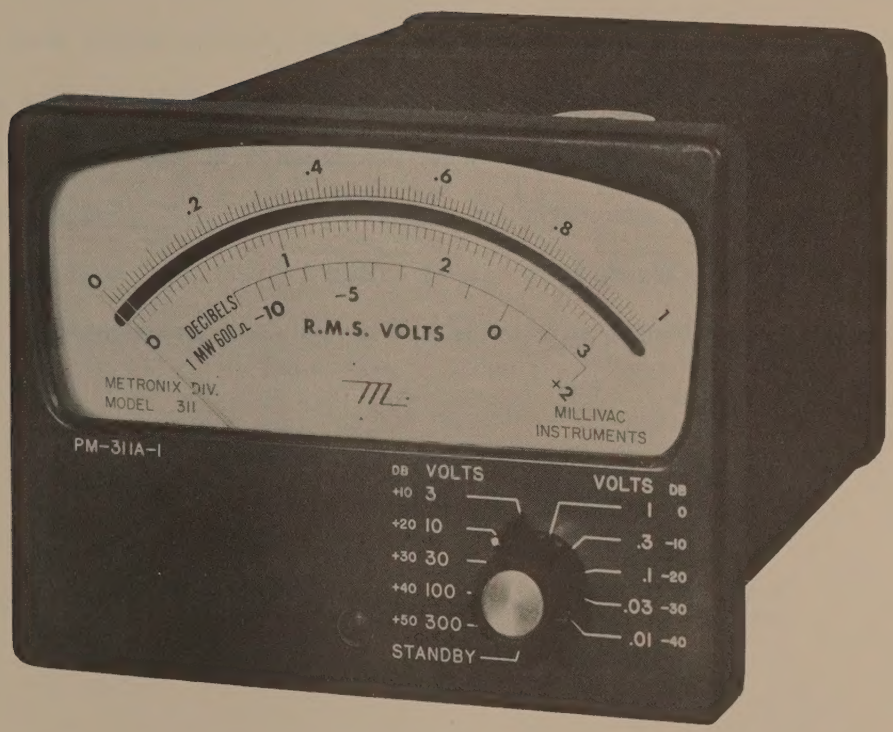
SER. NO.

MILLIVAC INSTRUMENTS

OPERATING AND SERVICING MANUAL

MODEL PM-311A-1
and
MODEL PM-311A

(PANEL MOUNTED)
AC MULTI-RANGE VOLTMETER



METRONIX Division of
MILLIVAC INSTRUMENTS, INC.

Schenectady, New York

P.O. Box 997

PHONE 518-355-8300

ADDENDUM SHEET FOR PM-311A AND PM-311A-1

The PM-311A and PM-311A-1 are equipped with a .47 mfd capacitor (C-14), installed between the dummy ground and chassis frame of the instrument (see schematic diagram).

Under normal conditions, this capacitor improves the residual noise level. On some installations, especially where measurements are to be made on servo's, etc., a high level signal may be injected into the ground system. This signal in turn may be transmitted into the amplifier by the above mentioned capacitor, C-14. In such cases, to eliminate the erroneous readings resulting from this error signal, it may be necessary to remove C-14. Removal of this capacitor will in no way affect the normal operation of the meter.

MILLIVAC INSTRUMENTS, INC.

Albert J. Hantzon

Albert J. Hantzon
Engineering Department

MILLIVAC
INSTRUMENTS, INC.

MANUAL CHANGES

MODEL NO.	PM-311A and PM-311A-1
TYPE	Panel-Mounted AC Voltmeters
SERIAL NO.	(PM-311A) 10279 and up - Change 1
SERIAL NO.	(PM-311A-1) 10217 and up - Change 1

Change 1: A. Section 5, Parts List and Schematic Drawing No. 311A-10029C

1. Change C4 to Capacitor, paper, mylar, 0.1μFD, 600V, Millivac P/N 621-1004, Mfr's. P/N Sprague 6PS-P10
2. Change R17, resistor to 47K, Millivac P/N 500-473
3. Change R21, resistor 220K, Millivac P/N 500-223

MILLIVAC
INSTRUMENTS

MANUAL CHANGES

MODEL NO. PM-311A and PM-311A-1 SERIAL NO. 11005 & up

TYPE AC Panel-mounted Voltmeter

CIRCUIT AND PARTS LIST CHANGES

1. C2, capacitor, 6-25pf replaced by 2.5-7pf
   Millivac Part No. 670-1016

2. C3, capacitor, .0047μfd - 600V replaced by
   2,000pf - 500V
   Millivac Part No. 660-1006

3. C4, capacitor, .1μfd - 600V replaced by
   .1μfd - 200V
   Millivac Part No. 630-1006

4. CR1-CR2, diodes, IN281 replaced by ED90
   Millivac Part No. 101-2007

5. ADD-R31, 5.1 meg, 1/2W carbon resistor
   Millivac Part No. 500-515 from Pin 8 of V1B
   to dummy ground.

Supplement B for 3-311A-1
9-17-69

MILLIVAC
INSTRUMENTS

MANUAL CHANGES

MODEL NO. PM-311A and PM-311A-1 SERIAL NO. 11005 & up

TYPE AC Panel-mounted Voltmeter

CIRCUIT AND PARTS LIST CHANGES

1. C2, capacitor, 6-25pf replaced by 2. 5-7pf
Millivac Part No. 670-1015

2. C3, capacitor, .0047μfd - 600V replaced by
2,000pf - 500V
Millivac Part No. 660-1006

3. C4, capacitor, 1μfd - 600V replaced by
1μfd - 200V
Millivac Part No. 630-1006

4. CR1-CR2, diodes, 1N281 replaced by ED90
Millivac Part No. 101-2007

5. ADD-R31, 5.1 meg, 1/2W carbon resistor
Millivac Part No. 500-5151 from Pin 8 of V1B
to dummy ground.

Supplement B for 3-311A-1
9-17-69

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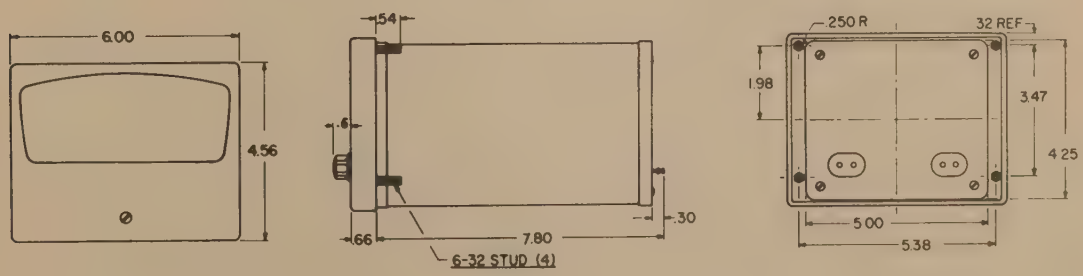
SPECIFICATIONS

ACCURACY: (PM-311A-1)	± 1% of FS from 50 cps - 50 KC ± 2% of FS from 30 cps - 100 KC ± 3% of FS from 20 cps - 250 KC
(PM-311A)	± 3% of FS from 50 cps - 50 KC ± 4% of FS from 30 cps - 100 KC ± 5% of FS from 20 cps - 250 KC
VOLTAGE RANGES:	0-10/30/100/300 Millivolts and 0-1/3/10/30/100/300 volts AC, R.M.S.
DB RANGES:	-40, -30, -20, -10, 0, +10, +20, +30, +40, +50
FREQUENCY RANGE:	20 cps - 250 KC
INPUT IMPEDANCE:	Approx. 5 megohms shunted by 25 μμF
TUBE COMPLEMENT:	(2) 6AN8A
POWER LINE REQUIREMENTS:	7 watts @ 115 V, 50/60 - 400 cps
LINE SHIFT ERROR:	Less than ± 1% with a variation in line voltage of ± 10%.
WEIGHT:	4.5 lbs.
CONNECTIONS:	Solder turret terminals
COLOR:	Dull black meter; black wrinkle dust cover

METER OUTLINE AND MOUNTING DIMENSIONS:



SECTION 1

GENERAL DESCRIPTION

1-1 FUNCTION OF THE INSTRUMENT

The PM-311A-1 model is a miniaturized, panel-mounted, AC multi-range electronic voltmeter with power supplies and operational controls built-in. It provides all the advantages of a V.T.V.M. yet occupies only as much panel space as a standard 6-inch indicating meter.

This instrument will measure voltages from .01 volts to 300 volts AC, RMS full scale over a frequency range of 20 cps to 250 KC. The input impedance is approximately 5 megohms shunted by less than 25 μμF.

The basic accuracy of the PM-311A-1 is ± 1% full scale on all ranges and can be used up to 250 KC with reduced accuracy.

Also available is the PM-311A model, which has a basic accuracy of ± 3% due to the fact that the meter movement is less accurate. However, in every other respect the two models are alike.

They both have a readable sensitivity of 0.5 millivolts, which is sufficient to measure hum level and noise directly. And will perform a variety of other functions such as measuring gain, network response, and signal level.

1-2 CONTROLS AND TERMINALS

A. Front Panel Controls.

This instrument is a multiple-range instrument with a range switch located on the front panel, which in this case is the bezel. The range switch positions are mounted in the following manner (from extreme counter-clockwise to clockwise): Standby/300/100/30/10/3/1/.3/.1/.03/.01 volts. The attenuator is also calibrated in db's and the ranges are as follows: Standby /+50/+40/+30/+20/+10/0/-10/-20/-30/-40 db. (See front page photograph of the meter).

B. Calibrating Controls.

There are seven calibrating controls. Two of these are part of the input attenuator and are identified as C2 and R3. The trimmer C2 is located within the input attenuator shield, and is accessible through an opening just beneath the 3 volt calibration potentiometer R3, which is mounted to the outside of the attenuator shield. These controls can be reached only with the dust cover removed. On the printed circuit board itself are four potentiometers, R9, R11, 13 and 15, and are part of the cathode follower attenuator. On a bracket mounted between the meter and the assembly is the main calibrating potentiometer, easily accessible on the top of the dust cover, through an opening marked "CALIBRATION - R18."

C. Terminals.

The power input terminals and the signal input terminals are located at the rear of the instrument. The layout of these can be seen from Figure 1-1.

If your instrument incorporates a meter relay, the contacts from the meter relay are usually placed in the upper left corner on the rear of the instrument and are properly labeled.

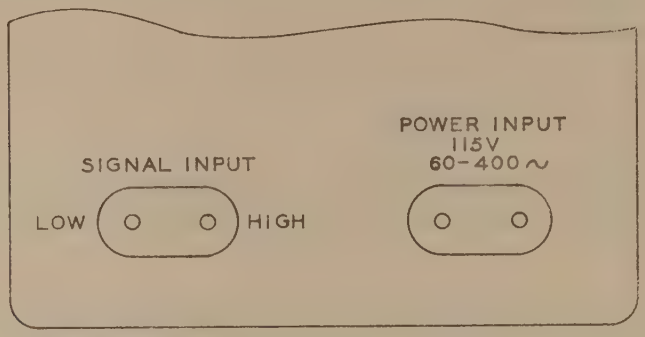


FIG. 1-1

D. Meter Mechanical Zero Adjustment Screw.

Whenever the meter pointer does not indicate zero exactly, the pointer should be reset. This naturally applies only to an instrument which is not under power.

The adjust screw is in the meter bezel at a midpoint immediately below the meter face. The adjustment is properly made only when the pointer is traveling in the opposite direction to the turn of the adjust screw. Though the adjust screw can turn in either direction, a practical procedure is to turn the screw in a clockwise direction until the pointer starts to swing back toward zero. Then, still turning the screw clockwise, bring the pointer up to zero.

NOTE: When the instrument is turned on, and the range switch is on STANDBY the meter pointer may rise above zero, but unless this residual reading exceeds two scale divisions (on the 0-1 scale) the accuracy of the instrument is not impaired.

SECTION 2

OPERATING INSTRUCTIONS

2-1 GENERAL

When Model PM-311A-1 is received from the factory, it is ready for use in the customer's equipment and no preliminary checks and adjustments will be necessary. Since it is designated for use in systems and test consoles, no "on-off" switch or pilot light has been provided.

2-2 POWER LINE REQUIREMENTS

The PM-311A-1 is supplied for 115 V, 50/60 - 400 cps operation. Variation in line voltage of as much as ± 10% will not affect the calibration and/or accuracy of the instrument.

2-3 ABOVE GROUND MEASUREMENTS

The circuitry of the instrument is electrically isolated from the case and the meter case back. The only limitations are isolation by a capacitor, C14 and the resistance of the insulating materials, which under normal operating conditions will remain constant around 10,000 megohms. Therefore, Model PM-311A-1 can be successfully used for AC voltage measurements floating above the ground of the circuit under test. The "LOW" terminal of this instrument should be connected to that point of the circuit under test which has the lowest impedance or voltage to power line ground.

2-4 GROUNDING THE CASE

Whether the instrument is used above ground or the "LOW" terminal is connected to the ground of the circuit under test, it is necessary that the case of the instrument be connected to the ground point of the equipment in which it is to be installed. This can be accomplished by establishing a connection between the mounting studs of the meter and either the unpainted portion of the panel back or a direct electrical connection to the ground point.

2-5 VOLTAGE MEASUREMENTS

A. Warm-up Time.

With the power connected to the instrument, allow about ten minutes to reach a state of stable operation.

B. The "Standby" Position of the Range Switch.

Since the input terminals are permanently connected to a signal source, the range switch has been provided with an additional position called "Standby". This is a position in which the signal remains connected across the full attenuator (thus no short of the signal is possible) but the grid of the cathode follower is connected to the low side of the voltmeter circuitry. From the "Standby" position, which is the most counter-clockwise one, switching to the desired range may be accomplished without causing unnecessary circuit overloading.

C. Input Breakdown Voltage

The maximum voltage (sum of the DC and AC peak voltages) applied to the input [illegible] down the capacitors in the input circuit of the instrument.

D. Meter Scales for Voltage Measurements.

The value of the voltage measured will be indicated on one of two scales: 0 to 1 volt or 0 to 3 volts. When the range used contains the integer "1", the value of the volt[illegible] integer "3", the value of the voltage will be indicated on the 3-volt scale. Each range [illegible] scale.

E. Indication.

[illegible] ing a true sine wave.

[illegible] the RMS value.

Of particular interest in normal measurement is the sine wave partially distorted by harmonically related sinusoids.

[illegible] magnitude shown in Table 1 may be anticipated.

TABLE 1 - Effect of Harmonics on Voltage Measurements

Input Voltage Characteristics	True RMS Value	Value Indicated
Fundamental = 100	100	100
Fundamental + 10% 2nd harmonic	100.5	100
Fundamental + 20% 2nd harmonic	102	100 - 102
Fundamental + 50% 2nd harmonic	112	100 - 110
Fundamental + 10% 3rd harmonic	100.5	96 - 104
Fundamental + 20% 3rd harmonic	102	94 - 108
Fundamental + 50% 3rd harmonic	112	90 - 116

This discussion in no way shows a limitation of the Model PM-311A-1 since these conditions are common to all average responding devices. It is mentioned to insure that any operator engaged in measurement will be fully apprised of the signal characteristics he measures. Input signals of a doubtful nature should be viewed on an oscilloscope.

F. DB Measurement.

Measurements in terms of decibels are made the same way as voltage measurements except that the meter indication is read on the db scale. The level in dbm is the algebraic sum of the meter db indication and the range switch position when the measurement is made across 600 ohms. However, the level differences may be read directly as db when the levels are measured across equal impedances.

TABLE II - Examples
(across 600 ohms)

Meter Indication	Range Position	DBM
- 6	- 10	- 16
+ 1	- 20	- 19

(Across Equal Loads)

Meter Indication	Range Position	DBM
A + 2	+ 10	+ 12
B - 3	- 10	- 13

db difference = A - B = 12 - (- 13) = 25 db

SECTION 3

DESCRIPTION OF CIRCUITRY

3-1 GENERAL

Figure 3-1 shows a block diagram of the Model PM-311A-1, which consists of an input system, acting as a voltage divider; a broadband amplifier, which amplifies the AC input signal; and a rectifier and meter section, which converts the AC voltage to DC current presented by the meter.

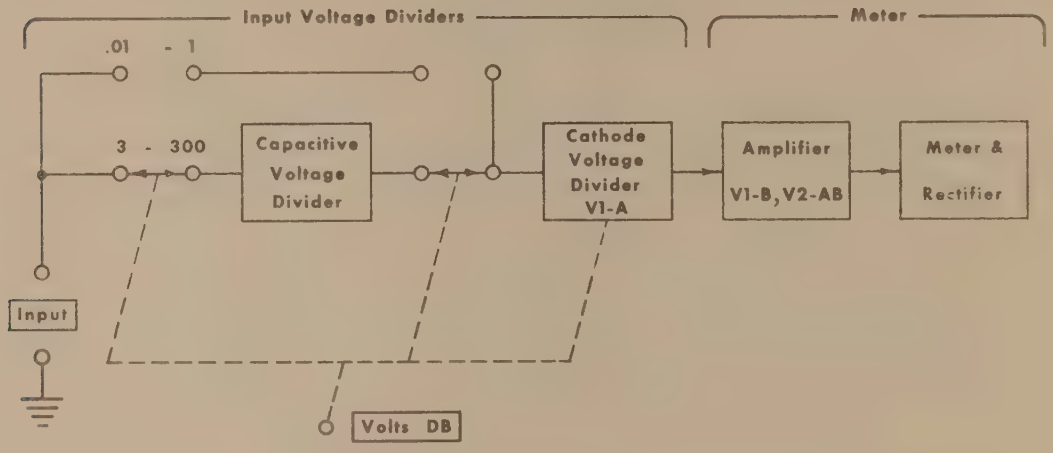


FIG. 3-1

3-2 INPUT VOLTAGE DIVIDER

The voltage divider section consists of two separate dividers. One is a resistance-capacitance voltage divider - frequency compensated, located in the grid portion. The other is an adjustable resistive divider in the cathode portion of the cathode follower stage.

The switching sequence from .01 volt position to the 1 volt position of the range switch covers the entire range of the cathode voltage divider in 10 db steps of attenuation.

At the 3 volts to 300 volts position, the resistance-capacitance voltage divider consisting of C2, C3, R1, R2 and R3 is placed in the grid circuit of the cathode follower stage and the whole sequence of the cathode portion of the voltage divider is repeated. In this manner the cathode voltage divider portion is used twice over; once without and once with the resistance-capacitance voltage divider in the grid portion of the cathode follower stage (V1-A).

3-3 VOLTMETER AMPLIFIER

The voltmeter amplifier using the tubes V1B and V2AB is a straight-forward frequency compensated circuit, accepting the AC signal from the cathode follower V1A and driving the rectifier and meter in its feedback circuit. The circuit operates in the following way; if the input signal reaching the grid of tube V1B increases, the feedback current (flowing between the cathode of the tube V2B and the cathode of the tube V1B) also increases. This current is metered and is linearly proportional to the input voltage change.

3-4 METER AND RECTIFIER

In the meter and rectifier section of the instrument, the AC feedback current is being rectified by the bridge consisting of CR1, CR2, R29 and R30 and consequently presented by the meter M1, which is in series with the calibrating potentiometer R18.

3-5 POWER SUPPLY

The power supply is of the regulated full-wave variety and uses two silicon rectifiers and a zener diode. Ample filtering is provided to assure stable measurement on 60 cps and its harmonics.

SECTION 4

MAINTENANCE AND SERVICE

4-1 GENERAL

Realiability is an implicit component of all METRONIX instruments. The following section in this manual has been formulated with the aim of instructing the user in the proper techniques needed to check an instrument's accuracy and maintain the equipment at its peak operating efficiency.

4-2 PERIODIC INSPECTION

Efficient quality control procedures require periodic functional checking of any measuring apparatus. The required test equipment and procedures for a proper and complete calibration are described in the following paragraph.

4-3 RE-CALIBRATION AND CALIBRATING PROCEDURES FOR PM-311A-1 and PM-311A

Re-calibration covers most points the maintenance engineer or technician must be acquainted with. The following procedure should be used:

1a) Without disassembling the Model PM-311A-1, energize the instrument with proper line voltage (115 volts, 50/60 cps or 400 cps).

1b) Connect a low distortion oscillator and accurate voltmeter (thermo-couple or electronic, average or RMS reading), having an accuracy of $\pm$ 0.5% or better, to the SIGNAL INPUT terminals.

1c) Set the Model PM-311A-1 range switch to the .01 volt position and apply .01 volt (as read on the accurate external voltmeter) at 400 cps. (For simplicity's sake one can use a 100 to 1 attenuator, having an accuracy of $\pm$ 1%, since most meters, which can be used for the monitoring of the input signal with the required accuracy, do not have a full scale sensitivity as low as .01 volt required in this application. In view of the relatively low frequency of 400 cps the attenuator can be made of non-inductive wire-wound resistors. Monitoring of the signal level can be done at 1 volt level, and the .01 volt signal will be available at the tap between the two resistors.)

1d) If the accuracy of the Model PM-311A-1 indication is within the specified value, repeat the same check on the .03, .1, .3 and 1 volt ranges. In the majority of cases, these ranges will be of the same accuracy as the .01 volt range.

1e) If the accuracy of the .01 volt range is not satisfactory, adjust R18 (CALIBRATION - R18), located under the dust cover, and accessible through an opening so marked, so that the indication of Model PM-311A-1 agrees with that of the external voltmeter.

1f) Set the Model PM-311A-1 range switch to the 3 volt position and apply 3 volts at 400 cps to the SIGNAL INPUT terminals, and change the sensitivity of the monitoring voltmeter to this range.

The calibration should agree. If it does not, follow the calibration procedure 2.

If any component or tube has been replaced in a faulty instrument, it is advisable to re-calibrate the Model PM-311A-1, following these steps:

2a) With the power disconnected, adjust the mechanical zero as per par. 1-2D.

2b) After the dust cover is removed, one of the meter studs should be connected to "ground" and the instrument provided with the proper line voltage (115 volts, 50/60 or 400 cps).

2c) Connect a low distortion oscillator and accurate voltmeter (thermo-couple or electronic, average or RMS reading), having an accuracy of ±0.5% or better, to the SIGNAL INPUT terminals.

2d) Set the Model PM-311A-1 range switch to the .01 volt position and apply .01 volts, (as read on the accurate external voltmeter) at 400 cps to the SIGNAL INPUT terminals. The technique described in (1c) can be used here.

2e) Adjust potentiometer R18 so that the Model PM-311A-1 indication corresponds to that of the external voltmeter.

If R18 does not have sufficient swing, R28 should be adjusted until R18 is electrically centered. This adjustment should not be necessary unless the indicating meter, M1 is changed.

Next, change the range switch to the .03 volt position and increase the oscillator level to .03 volt as indicated on the external voltmeter. Adjust potentiometer, R9 located close to the switch on the printed circuit board, so that the Model PM-311A-1 indication corresponds to that of the external voltmeter. (For reference see Fig. 4-2).
Similar adjustments should be made by calibration 0.1 volt range using R11; the .3 volt range, using R13; and the 1 volt range, using R15.

2f) After all five adjustments have been made, change the range switch to the 3 volt position and increase the oscillator level as well as the external meter's range to 3 volts. If the Model PM-311A-1 indication does not correspond to that of the external voltmeter, adjust the input attenuator ratio by means of the potentiometer R3 (located on the outside of the attenuator shield) until a proper reading is achieved.

2g) The ranges 10, 30, 100 and 300 volts should then be checked, and the readings should be well within the specified accuracy.

2h) Next the high frequency end of the PM-311A-1 should be adjusted. With the range switch, oscillator level, and external meter range on the .01 volt range, the oscillator frequency should be changed to 250 KC and adjusted to read 9 mV or 90% of full scale on PM-311A-1. If the readout of the PM-311A-1 is higher than the external meter (which should offer same degree of accuracy at 250 KC as at 400 cps), C5 (average value 200 μμF) should be adjusted until reading is within specifications. If PM-311A-1 reads lower, C7 (average value .003 μμF) should be adjusted until reading is within specifications. This completes frequency response adjustment of the basic range. Now switch PM-311A-1, oscillator level, and external meter to the 3 volt range. Adjust oscillator to 250 KC. If readout on PM-311A-1 differs from the external meter, adjust C2, located within the attenuator compartment accessible through an opening on the broad side of shield. If C2 is adjusted, the 3 volt range should be rechecked at 400 cps. (C2 and C3interact).

Method 2, described above, corresponds to that used by the factory. If followed, a successful calibration of the Model PM-311A-1 can be guaranteed.

An instrument especially suitable for use as an external standard voltmeter is the Sensitive Research Instruments, Inc. Model RFVOLT, which offers an extremely wide frequency response within the 1 and 3 volt ranges (in excess of 2 Mc), while maintaining a ± 0.5% accuracy. This is a thermo-couple instrument, so proper care should be exercised, since overload can cause permanent damage to the thermo-couple.

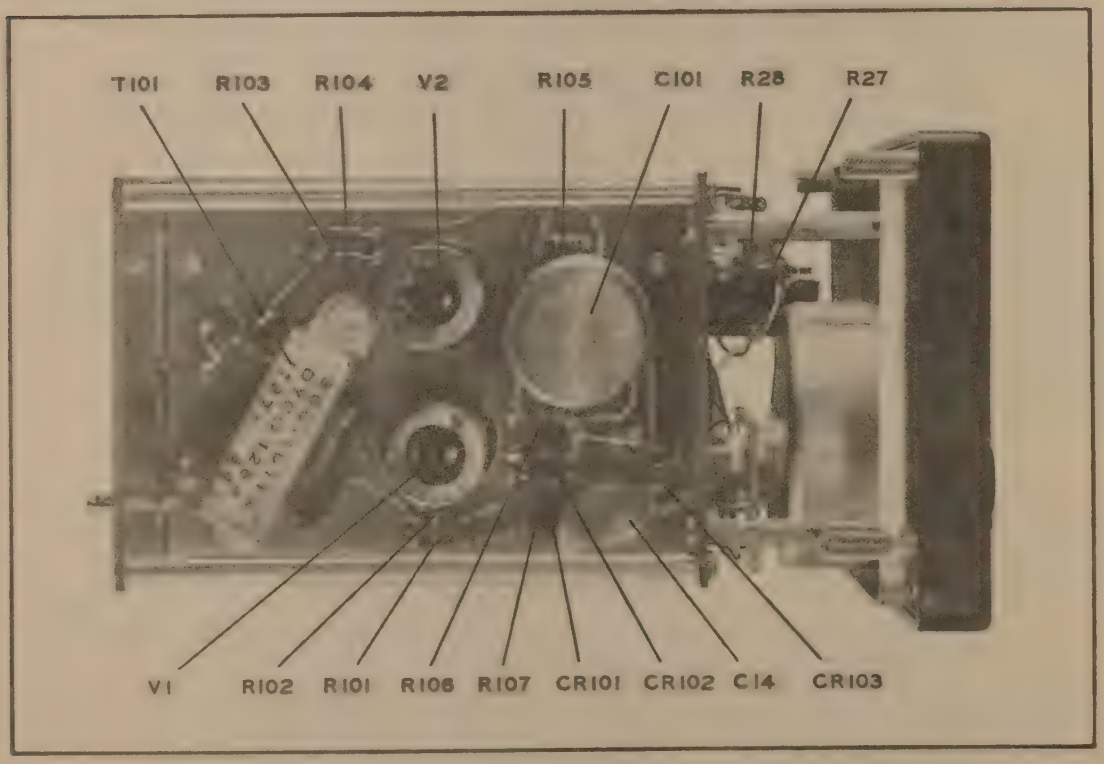


FIG. 4-1 Left Side View - Power Supply Board

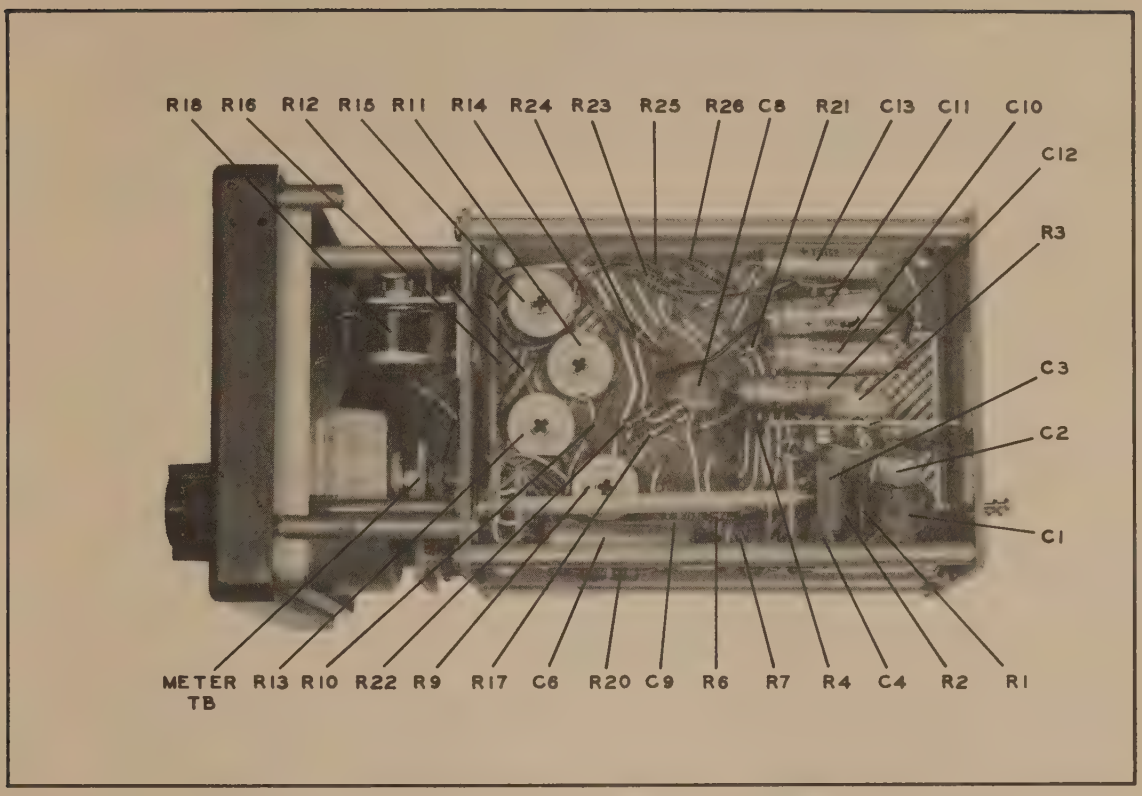


FIG. 4-2 Right Side View - Amplifier Board

4-4 SERVICE

A. General.

This instrument has been designed around two printed circuit coards, and utilizes components mounted directly to the boards. If it becomes necessary to change components, it is mandatory that the replacement parts be the same as specified in the parts list. The newly installed parts should be mounted in the exact manner and position as the original components (See Fig. 4-1 & 4-2). Otherwise, the operating characteristics of the instrument may alter the instruments accuracy.
METRONIX division of Millivac Instruments, Inc., maintains a service department, and it would be advisable, in case of major repairs, to return the instrument in question to Millivac. This is especially advisable because some of the components used are not available from the stock of local parts distributors.

B. Tube Replacement.

Any tube in the Model PM-311A-1 may be replaced with another of the same type having standard RETMA characteristics. Whenever a tube is replaced, re-calibration will be necessary.

C. Component Replacement.

Tube replacements will, in most instances, restore Model PM-311 A-1 to normal operation. If it does not, the following recommendations may aid in the location of a faulty component so that remedial service may be performed.

A careful consideration of the circuit diagram will show that standard signal tracing techniques shall be used to localize the faulty components.

If results are not achieved by this technique, the indicating meter itself should be disconnected and replaced with another having a sensitivity of 200μA f.s., so as to determine whether the indicating meter itself is faulty.

D. Faulty Meter Movement.

Meter movements are precise electro-mechanical devices and should be handled only by trained personnel. Therefore, do not attempt to repair meters, unless specialists in your organization are trained for the job.

4-5 REPAIR OF PRINTED CIRCUIT BOARDS

Here are several basic rules in order;

1. When servicing printed circuits DO NOT push or pull wires in such a way as to raise the printed wiring from the board.

2. When soldering leads, use a 50 watt iron or smaller. Apply heat sparingly to the leads on the part to be replaced, not on the printed wiring on the board.

3. Before installing new parts, clean the holes so as to receive the new parts without forcing. New leads should be tinned and if necessary fluxed to receive solder quickly with a minimum of heat and without residue.

SECTION 5

Parts List for the PM-311A and PM-311A-1

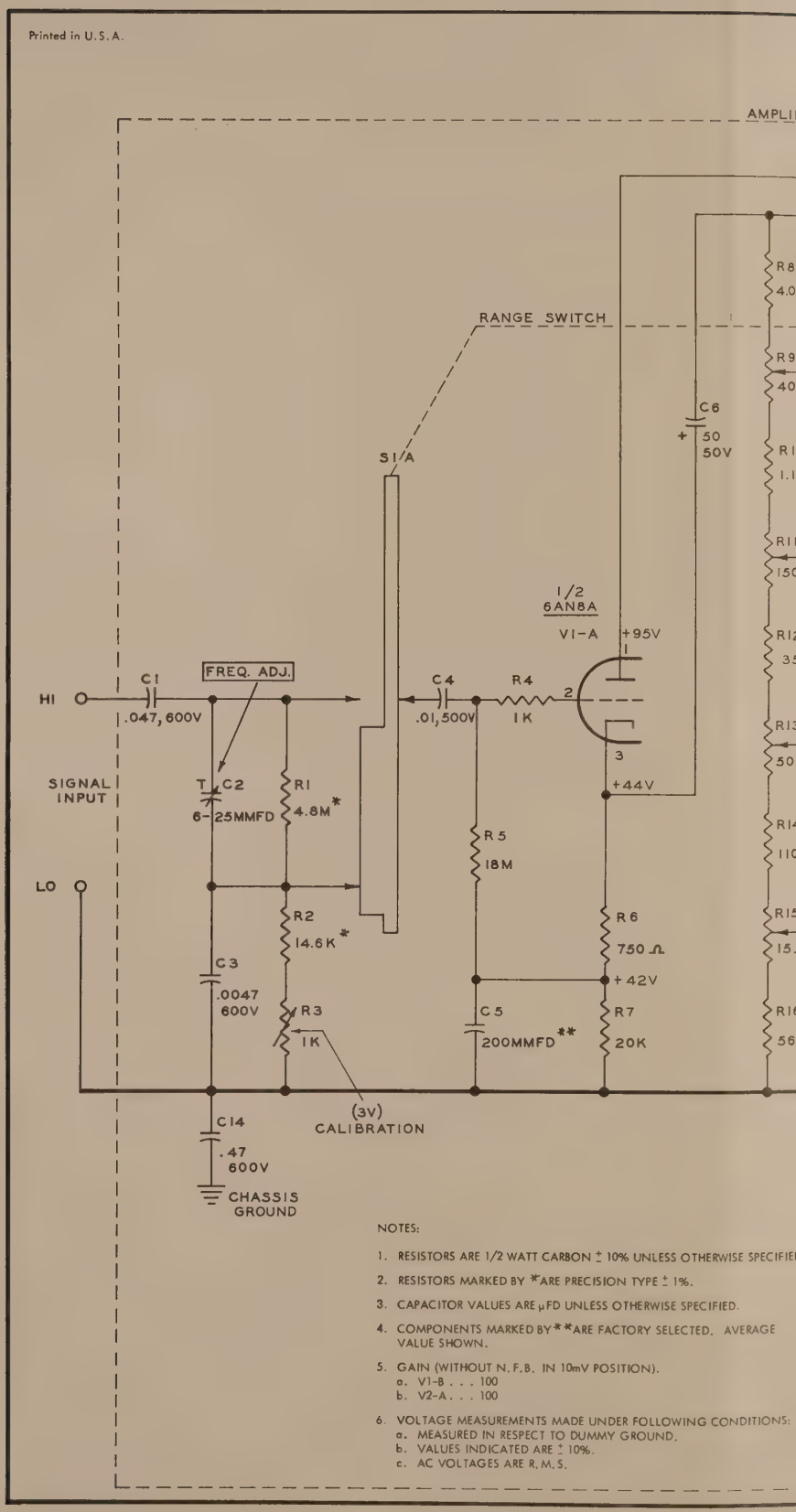
CKT SYM	Description	Metronix Part No.	Manufacturer & Mfr.'s. Part No.
C1	Capacitor, paper, mylar, .047μfd, 600V	621-1006	6PS-S47
C2	" trimmer, 6-25μfd	670-1012	Erie Type 3192NPO
C3	" mica, .0047μfd, 600V	660-1014	CM30E472-J
C4	" ceramic, disc. .01μfd, 500V	610-1009	Erie ED-.01
C5*	" mica, 200μμfd, 500V		
C6	" electrolytic, 50μfd, 50V	635-1005	TE-1307
C7*	" mica, .003μfd, 500V		
C8	" paper, mylar, 0.1μfd, 600V	621-1004	6PS-P10
C9	" electrolytic, 10μfd, 150V	635-1002	TE-1507
C10 thru C13	Same as C9		
C14	Capacitor, paper, mylar, 0.47μfd, 600V	621-1008	Mallory PVC-6047
C101	Capacitor, electrolytic, 50-30-30μfd, 250-150-150V	650-1001	
CR1	Diode, germanium	101-0281	Transitron 1N281
CR2	Same as CR1		
CR101	Diode, silicon	101-0500	CER-500A
CR102	Same as CR101		
CR103	Diode, zener	101-1100	Sarkes-Tarzian 1T-100
M1	Meter, indicating, movement, 0-200μA		
	for PM-311A	203-2040	
	for PM-311A-1	203-2041	
R1	Resistor, carbon film, 4.8M ± 1%, 1/2W	520-4804	
R2	" metal film, 14.6K ± 1%, 1/4W	512-1462	
R3	" wire-wound, linear taper, variable 1K, 1/4W	580-1000	
R4	Resistor, composition, 1K ± 10%, 1/2W	500-102	
R5	" " 18M ± 10% 1/2W	500-186	
R6	" " 750Ω ± 10% 1/2W	500-751	
R7	" " 20K ± 10% 1/2W	500-203	
R8	Resistor, metal film, 4K ±1% 1/4W	512-4001	
R9	Resistor, wire-wound, variable, linear taper 400Ω ± 20% 1/4W	580-1001	
R10	Resistor, metal film, 1.1K ± 1%, 1/4W	512-1101	
R11	Resistor, wire-wound, variable, linear taper, 150Ω ± 20% 1/4W	580-1002	

* Selected at factory; average value shown

CKT	Description	Metronix Part No.	Manufacturer & Mfr's. Part No.
R12	Resistor, metal film, 350Ω ±1%, 1/4W	512-3500	
R13	Resistor, wire-wound, variable, linear taper, 50Ω ±20%, 1/4W	580-1003	
R14	Resistor, metal film, 110Ω ±1%, 1/4W	512-1100	
R15	Resistor, wire-wound, variable, linear taper, 15Ω ±20%, 1/4W	580-1004	
R16	Resistor, metal film, 56.2Ω ±1%, 1/4W	512-56R2	
R17	Resistor, composition, 82K ±10%, 1/2W	500-823	
R18	Resistor, wire-wound, variable, linear taper, 2.5K ±20%. 1/4W	580-1005	
R19	Resistor, composition, 1.6K ±10%, 1/2W	500-162	
R20	Resistor, wire-wound, 10Ω ±10%. 1/2W	510-100	
R21	Resistor, composition, 300K ±10%, 1/2W	500-304	
R22	Resistor, composition, 1M ±10%, 1/2W	500-105	
R23	Resistor, composition, 68K ±10%, 1/2W	500-683	
R24	Resistor, composition, 1K ±10%, 1/2W	500-102	
R25	Resistor, composition, 150K ±10%, 1/2W	500-154	
R26	Resistor, composition, 15K ± 10%, 1/2W	500-153	
R27	Resistor, metal film, 1.5K ±1%, 1/4W	512-1501	
R28*	Resistor, metal film, 750Ω ±1%, 1/4W		
R29	Resistor, composition, 1.5K ±10%, 1/2W	500-152	
R30	Same as R29		
R101	Resistor, composition, 15Ω ±10%, 1/2W	500-150	
R102	Same as R101		
R103	Resistor, composition, 47Ω ±10%, 1/2W	500-470	
R104	Same as R103		
R105	Resistor, composition, 3.3K ±10%, 1/2W	500-332	
R106	Same as R105		
R107	Resistor, composition, 3.9K ±10%, 1/2W	500-392	
S1	Switch, range, rotary	410-1002	
T101	Transformer, power	300-1011A	
V1	Tube, electron, 6AN8A	110-1204	RCA6AN8A
V2	Same as V1		
	Miscellaneous		
	Knob, Range Switch	800-4131	Buckeye PS-50BL-2
	Shield, Tube (2 required)	110-5040	Elco 191
	Dust Cover	820-2004	

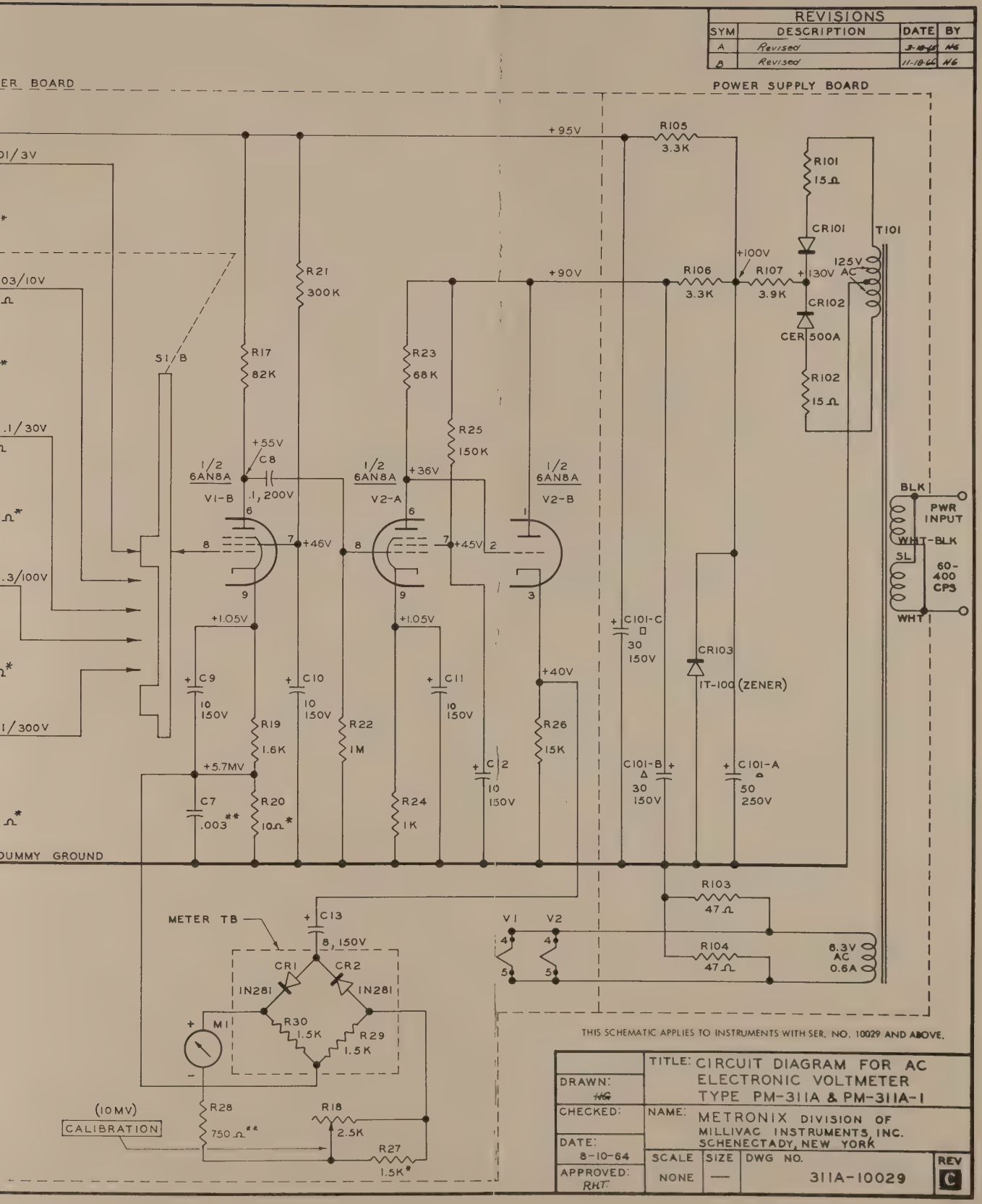
* Selected at factory, average value shown

Printed in U.S.A.



NOTES:

1. RESISTORS ARE 1/2 WATT CARBON ± 10% UNLESS OTHERWISE SPECIFIE
2. RESISTORS MARKED BY * ARE PRECISION TYPE ± 1%.
3. CAPACITOR VALUES ARE μFD UNLESS OTHERWISE SPECIFIED.
4. COMPONENTS MARKED BY ** ARE FACTORY SELECTED. AVERAGE VALUE SHOWN.
5. GAIN (WITHOUT N.F.B. IN 10mV POSITION).
   a. V1-B . . . 100
   b. V2-A . . . 100
6. VOLTAGE MEASUREMENTS MADE UNDER FOLLOWING CONDITIONS:
   a. MEASURED IN RESPECT TO DUMMY GROUND.
   b. VALUES INDICATED ARE ± 10%.
   c. AC VOLTAGES ARE R.M.S.


REVISIONS
SYM DESCRIPTION DATE BY
A Revised 3-10-65 NG
B Revised 11-10-66 NG
ER BOARD
POWER SUPPLY BOARD
+95V
R105 3.3K
R101 15Ω
CR101
T101
+100V
125V
+130V AC
+90V
R106 3.3K
R107 3.9K
CR102
CER 500A
R102 15Ω
R21 300K
R17 82K
R23 68K
R25 150K
S1/B
+55V
C8 .1, 200V
1/2 6AN8A V1-B
1/2 6AN8A V2-A
+36V
1/2 6AN8A V2-B
+46V
+45V
BLK
PWR INPUT
WHT-BLK
SL
60-400 CPS
WHT
+1.05V
+1.05V
C9 10 150V
C10 10 150V
C11 10 150V
C101-C 30 150V
CR103 IT-100 (ZENER)
+40V
R19 1.6K
R22 1M
R26 15K
+5.7MV
C7 .003 **
R20 10Ω*
R24 1K
C12 10 150V
C101-B 30 150V
C101-A 50 250V
DUMMY GROUND
R103 47Ω
METER TB
+ C13 8, 150V
V1 V2
R104 47Ω
6.3V AC 0.6A
CR1 IN281
CR2 IN281
M1
R30 1.5K
R29 1.5K
(10MV) CALIBRATION
R28 750Ω**
R18 2.5K
R27 1.5K*
THIS SCHEMATIC APPLIES TO INSTRUMENTS WITH SER. NO. 10029 AND ABOVE.
DRAWN: NG
CHECKED:
DATE: 8-10-64
APPROVED: RHT
TITLE: CIRCUIT DIAGRAM FOR AC ELECTRONIC VOLTMETER TYPE PM-311A & PM-311A-1
NAME: METRONIX DIVISION OF MILLIVAC INSTRUMENTS, INC. SCHENECTADY, NEW YORK
SCALE NONE
SIZE —
DWG NO. 311A-10029
REV C

GUARANTEE

Millivac Instruments, Inc. guarantees each instrument manufactured by us to be free from defects in material and workmanship for a period of one year from date of delivery to the original purchaser. Repairs during this time will be made by us free of charge, but transportation charges both ways will be borne by the customer.

Excluded from this guarantee are tube and transistor replacements, as well as all damages caused by, or related to, abuse of the instrument either electrically or mechanically. In this case, repairs will be billed at cost and an estimate will be submitted for your approval before the work is started.

If an instrument is believed to be defective, please notify our Service Department, giving the model number and serial number of the instrument, as well as describing the nature of the trouble. Our Service Department will then, if necessary, authorize the return of the instrument under the terms of this guarantee and advise how shipment should be made.

CLAIM FOR DAMAGE IN SHIPMENT

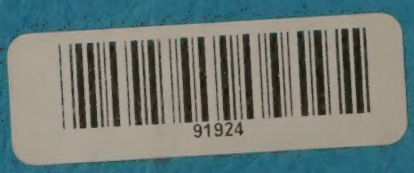
If, on receipt, the shipping cartons appear to be crushed or torn, as evidencing rough treatment, a notation should be made on the carrier's delivery receipt indicating this condition.

As each item is opened, it should be inspected to ascertain that no damage has been incurred during shipment. If no damage is visible, operational checks should be performed to make sure that the equipment arrives in its original operating condition. If any damage is revealed, a claim should be filed immediately with the carrier, stating the extent of the damage. A copy of this report should be forwarded to us along with the model and serial number of the instrument. Millivac will then advise how the instrument should be returned for repair or replacement.

SHIPPING INSTRUCTIONS FOR RETURNS TO FACTORY

No instrument should be returned to the factory without prior authorization from Millivac Instruments, Inc. or our authorized representative.

Shipping instructions will be given at the time return of an instrument is authorized. In all cases the instrument should be packed in a strong container and surrounded by sufficient shock-absorbing material.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